C. Acceptance

1. Toughness Tests

   Charpy V-Notch tests are mandatory for materials designated on the Plans as main load-carrying member components subject to tensile stress.

   a. Sample the steel according to ASTM A 673/A 673M.

   b. Perform the Charpy V-Notch test according to ASTM E 23.

D. Materials Warranty

General Provisions 101 through 150.

Section 852—Miscellaneous Steel Materials

852.1 General Description

This section includes the requirements for miscellaneous materials, such as:

- Steel bolts, nuts, and washers
- Anchor bolts, nuts, and washers
- High tensile strength bolts, nuts, and washers
- Corrugated steel plank for bridges
- Steel grid for bridge floors

852.1.01 Related References

A. Standard Specifications

Section 106—Control of Materials

B. Referenced Documents

ASTM		
A 123/A 123M	A 570/A 570M	E 376
A 153M/A 153M	A 653/A 653M	F 436
A 325/A 325M	A 709/A 709M	F 568M
A 490/A 490M	A 924/A 924M	F 606 (F 606M)
A 563/A 563M	B 695	F 844
		Recommended Practice E376

ANSI B 1.1M

AASHTO M 314

852.2 Materials

852.2.01 Steel Bolts, Nuts, and Washers

A. Requirements

1. Bolts and Nuts

   a. Use bolts and nuts, hex or heavy hex as required, that meet the applicable requirements of ASTM F 568M.

   b. Ensure all threads meet the requirements of the latest issue of ANSI B 1.1(B 1.1M).

   c. Use bolts that have Class 2A (6H) threads.

   d. Use nuts that have Class 2 B (6G) threads.

   e. Ensure bolts that transmit shear are threaded so that no more than one thread will be within the grip of the metal.

   f. Use bolts long enough to extend entirely through the nut but no more than 1/4 in (6 mm) beyond them.

2. Washers

   Use washers that meet the requirements of ASTM F 844 unless otherwise specified.

B. Fabrication

Galvanizing: When galvanized materials are specified, galvanize all bolts, nuts, and washers by either the hot-dip method in ASTM A 153/A 153M, Class C, or the mechanical deposit method in ASTM B 695, Class 50.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

General Provisions 101 through 150.

852.2.02 Anchor Bolts, Nuts, and Washers

A. Requirements

1. Use anchor bolts, nuts, and washers for structural supports that meet the requirements of AASHTO M 314 Grade 55 (379) unless otherwise shown on the Plans. Supports include those for highway signs, street lighting, traffic signals, bridge bearing plates, and other similar applications.

   Apply Supplementary Requirement S1 of AASHTO M 314 to these materials.

2. Use the grade, shape, and dimensions designated on the Plans.

NOTE: The Department will not accept Grade 105 (724).

B. Fabrication

Galvanizing: Where galvanized materials are specified, galvanize all bolts, nuts, and washers by the hot-dip method in ASTM A 153/A 153M and according to the Plans.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

General Provisions 101 through 150.

852.2.03 High Tensile Strength Bolts

A. Requirements

1. Bolt Type

   Use high tensile strength bolts that meet the requirements of ASTM A325 (A 325M) or ASTM A 490 (A 490M), as specified on the Plans.

2. Nut Type

   Apply these changes to ASTM A 325 (A 325M) and/or ASTM A 490 (A 490M):

   a. Use only the following nuts for the listed high tensile-strength bolts:

Bolt Spec., Type and Finish	Nut Spec., Grade and Finish
A 325 (A 325M), 1 or 2, plain	A 563—DH or DH 3, plain, A194, 2H, plain (A 563M—8S or 8S3, plain)
A 325 (A 325M), 1or 2, zinc coated	A 563—DH, zinc coated, A194, 2H, zinc coated (A 563M—8S, zinc coated)
A 325 (A 325M), 3, plain	A 563—DH 3 plain (A 563M—8S3, plain
A 490 (A 490M), 1 or 2, plain	A 563—DH or DH3, plain, A 194, 2 H, plain (A 563M—10S or 10S3, plain)
A 490 (A 490M), 3, plain	A 563—DH 3, plain (A 563M—10S3, plain)

   b. Ensure all galvanized nuts meet the Supplementary Requirements of ASTM A 563 (A 563M).

3. Washer Type

   Apply these changes to ASTM A 325 (A 325M) and/or ASTM A 490 (A 490M):

   a. For bolts that meet ASTM A 325 (A 325M) or ASTM A 490 (A 490M), use washers that meet the requirements of ASTM F 436.

   b. Use washers that have the same coating or surface finish as the bolts and nuts.

4. Fastener Assemblies

   Provide the Office of Materials and Research at least three samples per lot of each material type furnished to project.

5. Certification Test Reports

   Supply certifications on each item according to Subsection 106.05, "Materials Certification." Include on all certifications the item specification number, type or grade, finish, and manufacturer's product-marking symbol.

   Also, supply the required Mill Test Reports, Manufacturer Certified Test Reports, and Distributor Certified Test Reports with each shipment, as follows:

   a. Mill Test Reports (MTR): Provide an MTR for all mill steel used to manufacture bolts, nuts, and washers. Indicate where the material was melted and manufactured.

   b. Manufacturer Certified Test Reports (MCTR): Supply the MCTR to the Department from the manufacturer of the bolts, nuts, or washers. Each MCTR shall:

      1) Show relevant information required by ASTM A 325 (A 325M) or ASTM A 490 (A 490M), and this Specification, including test results for any required coating.

      2) Include the lot number and location where the bolts, nuts, or washers were manufactured.

      3) If the manufacturer furnished the entire assembly (bolts, nuts, and washers), have the manufacturer perform the rotational capacity tests.

      4) Furnish the results and when and where all testing was performed.

   c. Distributor Certified Test Reports (DCTR): If a distributor purchases the various assembly components from different manufacturers, the distributor may run the rotational-capacity test in lieu of a manufacturer. In this case show test results, manufacturer's component lot numbers, and assigned rotational capacity lot numbers for each combination on the DCTR.

   d. The distributor is responsible for furnishing the required MTR, MCTR, and DCTR with each shipment.

B. Fabrication

1. Bolts

   a. If coating ASTM A 325 (A 325M) bolts with zinc, use either the hot-dip or mechanically deposited process.

   b. Do not hot-dip or electroplate ASTM A 490 (A 490M) bolts with any metallic coating. The bolts become brittle in hydrogen and subsequently crack due to stress corrosion and delayed brittle failure.

   c. Apply these changes to ASTM A 325 (A 325M) and/or ASTM A 490 (A 490M) for bolts:

      1) Test ASTM A 325 (A 325M) galvanized bolts for embrittlement according to ASTM F 606/F 606M, Section 7.

      2) Perform proof load tests (ASTM F 606/F 606 Method 1) for all ASTM A 325 (A 325M) and ASTM A 490 (A 490M) bolts.

2. Nuts

   a. Lubricate galvanized nuts with a lubricant that is clean and dry to the touch. Use a lubricant that has a color that contrasts with the zinc coating so that you can obviously see the coating at the job site.

   b. Perform proof load tests for all nuts, plain and zinc coated, using the method described in ASTM F 606/F 606M Section 4.2.

   c. If you use the nuts with galvanized bolts, run the proof load test after the nut is galvanized, overtapped, and lubricated.

3. Fastener Assemblies (Bolt, Nut, and Washer)

   a. Unless otherwise approved by the Engineer, coat the assemblies with a zinc coating according to ASTM A 153/A 153M.

   b. Take coating thickness measurements on the wrench flats.

   c. No single spot coating thickness measurement shall be less than the required individual specimen value shown on Table 1 of ASTM A 153/A 153M, when taken according to ASTM Recommended Practice E 376.

C. Acceptance

1. Fastener Assemblies (Bolt, Nut, and Washer)
   a. Take coating thickness measurements on the wrench flats according to ASTM Recommended Practice E 376.
   b. Ensure no single coating thickness measurement is less than the required individual Specimen value shown on Table 1 of ASTM A 153/A 153M.
2. Hardness Test

   Perform hardness tests on galvanized components after galvanizing the item and removing the coating.
3. Rotational Capacity Test

   Rotational capacity tests are required on all black or galvanized (after galvanizing) assemblies prior to shipping. The following directions are for Department personnel:
   a. Test each combination of bolt production lot, nut lot, and washer lot as an assembly.
   b. The Project Engineer may require additional rotational-capacity tests on assemblies covered by Subsections 852.2.03.C.4.b.7 and 852.2.03.C.4.b.9.
4. Rotational Capacity Test: Bolts Too Short to Fit in Tension Calibrator
   a. Equipment Required:
      - Calibrated manual torque wrench and a 1ft (300 mm) long wrench.
      - Spacers and/or washers with holes that do not exceed the bolt diameter by 1/16 in (2 mm) for bolts equal to or less than 1 inch (24 mm) in diameter. The hole size for larger bolts shall not exceed the bolt diameter by 1/8 in (3 mm).
      - Steel section with holes to match bolt sizes.

NOTE: Use a plate thick enough to accomplish Step 1 in the procedure without spacers. However, spacers are acceptable.

   b. Procedure:
      1) Mark off a vertical line and lines one-third of a turn, 120 degrees; half of a turn 180 degrees; and two-thirds of a turn, 240 degrees from vertical in a clockwise direction on the plate.
      2) Measure the bolt length, the distance from the underside of the bolt head to the end of the bolt.
      3) Install a nut on the bolt and measure the stick-out of the bolt when three to five full threads of the bolt are located between the bearing face of the nut and the bolt head.
      4) Install the bolt in the appropriate size hole and, if necessary, install the required number of spacers to produce the thread stick-out measured in step 1 (always use at least one washer under the nut).
      5) Snug the nut with the hand wrench. Snug should be the normal effort applied to a 12 in (300 mm) long wrench. Do not exceed 20 percent of the torque determined in step 7.
      6) Align the nut with the vertical (0 degree) stripe on the test frame plate. This is for reference after you rotate the nut during testing.
      7) Tighten the bolt by turning the nut with the torque wrench to the rotation in the table.

Bolt Length (Step 1)	4 bolt dia. or less	4 to 8 bolt dia.	More than 8 bolt dia.
Required rotation	1/3	1/2	2/3

      Use a second wrench to prevent the bolt from turning.
      8) Measure and record the torque required to reach this rotation. Measure torque with the nut in motion. Ensure the torque in foot-pounds (newton-meters) does not exceed the values in the table. Reject any assemblies that exceed the listed torques.

Nominal Bolt Dia., in (mm)	Torque, Foot-pounds (newton-meters)	
	ASTM A 325(A 325M)	ASTM A 490 (A 490M)
1/2 (M16)	150 (419)	180 (525)
5/8 (M20)	290 (817)	370 (1026)
3/4 (M22)	500 (1111)	625 (1395)
7/8 (M24)	820 (1415)	1020 (1773)
1 (M27)	1230 (2070)	1540 (2592)
1-1/8 (M30)	1500 (2813)	2160 (3520)
1-1/4 (M36)	2140 (4912)	3150 (6158)
1-3/8	2810	3980
1-1/2	3690	5310

9) Continue tightening the nut as follows:

Bolt Length (Step 1)	4 bolt dia. or less	4 to 8 bolt dia.	More than 8 bolt dia.
Required Rotation	2/3	1	1-1/3

10) Measure the rotation from the initial marking in Step 6.

11) Loosen and remove the nut and examine the bolt and nut threads. Reject any assembly that shows evidence of thread shear, stripping, or torsional failure.

NOTE: Reject any assemblies that fracture or are stripped before reaching the required rotation.

5. Rotational Capacity Test: Long Bolts in Tension Calibrator

a. Equipment required:

- Calibrated, measuring device to measure tension for the bolts. Mark off a vertical line and lines one-third of a turn, 120 degrees; and two-thirds of a turn, 240 degrees, from vertical in a clockwise direction on the face plate of the calibrator.
- Calibrated manual torque wrench.
- Spacers and/or washers meeting the requirements of Subsection 852.2.03.C.4.a, bullet 2.
- Steel section to mount the bolt calibrator.

b. Procedure

1) Measure the bolt length, the distance from the underside of the bolt head to the end of the bolt.

2) Put the nut on the bolt and measure the stick-out of the bolt when three to five full threads of the bolt show between the bearing face of the nut and the bolt head.

3) Install the bolt in the tension calibrator. If necessary, install the required number of spacers to produce the thread stick-out measured in step 1 (always use at least one washer under the nut).

4) Tighten the bolt by turning the nut with a hand wrench to the snug tensions listed below [–0 +2 kips (– 0 +9 kN)].

Nominal Bolt Dia., in (mm)	Tension, kips (kN)	
	ASTM A 325 (A 325M)	ASTM A 490 (A 490M)
1/2 (M16)	1(9)	1 (11)
5/8 (M20)	2 (14)	2 (18)
3/4 (M22)	3 (18)	4 (22)

Nominal Bolt Dia., in (mm)	Tension, kips (kN)	
	ASTM A 325 (A 325M)	ASTM A 490 (A 490M)
7/8 (M24)	4 (21)	5 (26)
1 (M27)	5 (27)	6 (33)
1-1/8 (M30)	6 (33)	8 (41)
1-1/4 (M36)	7 (47)	10 (60)
1-3/8	9	12
1-1/2	10	15

5) Align the nut to the vertical (0 degree) stripe on the face plate of the bolt calibrator.
6) Use the calibrated manual torque wrench to turn the nut to at least the tension in kips (kN) listed below.

Tension, kips (kN)		
Nominal Bolt Dia., in (mm)	ASTM A 325 (A 325M)	ASTM A 490 (A 490M)
1/2 (M16)	12 (91)	15 (114)
5/8 (M20)	19 (142)	24 (179)
3/4 (M22)	28 (176)	35 (221)
7/8 (M24)	39 (205)	49 (257)
1 (M27)	51 (267)	64 (334)
1-1/8 (M30)	56 (326)	80 (408)
1-1/4 (M36)	71 (475)	102 (595)
1-3/8	85	121
1-1/2	103	148

7) Record both the torque required to reach the tension and the bolt tension value from the calibrator.
   Measure torque with the nut in motion. The torque cannot be greater than 0.25 x the developed tension in lbf (newtons) x the bolt diameter in feet (meters).
8) Reject assemblies with torque values that exceed the calculated value.
9) Further tighten the nut as follows.

Bolt Length (Step 1)	4 bolt dia. or less	4 to 8 bolt dia.	More than 8 bolt dia.
Required Rotation	2/3	1	1-1/3

10) Measure the rotation from the initial marking in step 5.
11) Record the bolt tension. Reject assemblies that fail prior to this rotation either by stripping or fracture.
12) After the required rotation, the bolt tension in kips (kN) must equal or exceed the values shown in the table. Reject assemblies that do not meet the tension.

Nominal Bolt Dia., in (mm)	Tension, kips (kN)	
	ASTM A 325 (A 325M)	ASTM A 490 (A 490M)
1/2 (M16)	14 (105)	17 (131)
5/8 (M20)	22 (163)	28 (205)
3/4 (M22)	32 (202)	40 (254)

Nominal Bolt Dia., in (mm)	Tension, kips (kN)	
	ASTM A 325 (A 325M)	ASTM A 490 (A 490M)
7/8 (M24)	45 (236)	56 (295)
1 (M27)	59 (307)	74 (384)
1-1/8 (M30)	64(375)	92 (469)
1-1/4 (M36)	82 (546)	121 (684)
1-3/8	98	139
1-1/2	118	170

13) Loosen and remove nut and examine the bolt and nut threads. Reject any assembly with any evidence of thread shear, stripping, or torsional failure.

D. Materials Warranty

1. Ship bolts, nuts, and washers from each rotational-capacity lot in the same container.
   a. If shipping only one production lot number for each size nut and washer, you may ship the nuts and washers in the same container.
   b. Permanently mark each container with the rotational-capacity lot number so that identification will be possible at any stage before installation.
2. Black bolts, nuts and washers must be "oily" to the touch when installed. Clean and re-lubricate weathered or rusted bolts, nuts, and washers before installing them.
3. Improperly stored galvanized assemblies will develop white rust. Clean and re-lubricate as in Subsection 852.2.03.B.2.a any bolts, nuts, and washers that show evidence of white rust.

852.2.04 Corrugated Steel Plank for Bridges

A. Requirements

1. Type

   Use steel that meets ASTM A 570/A 570M Grade 33/230 or ASTM A 653/A 653M Grade 37/255 and ASTM A 924/A 924M.
2. Furnish copper steel when specified.
3. Submit a certification according to Subsection 106.05, "Materials Certification."

B. Fabrication

1. Make corrugated steel bridge plank of shop-fabricated steel plate. Use the gauge shown on the Plans.
2. Form the steel into plank at least 13 in (325 mm) wide and between 2 to 4 in (50 and 100 mm) deep, with at least two complete corrugations.
3. Galvanizing

   When galvanized plank is specified, galvanize the plank as in ASTM A 123/A 123M or ASTM A 653/A 653M Class G210.

C. Acceptance

Acceptance is based on the certification.

D. Materials Warranty

General Provisions 101 through 150.

852.2.05 Steel Grid for Bridge Floors

A. Requirements

1. Use steel that meets ASTM A 709/A 709M Grade 36/250, and has the specified copper content.
2. Submit a certification according to Subsection 106.05, "Materials Certification."

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

Acceptance is based on the certification.

D. Materials Warranty

General Provisions 101 through 150.

Section 853—Reinforcement and Tensioning Steel

853.1 General Description

This section includes the requirements for reinforcement and tensioning steel, including:

- Steel bars
- Pretensioning steel wire strand
- Post-tensioning steel wire
- Post-tensioning steel bars
- Plain steel bars with threaded ends
- Steel wire
- Welded steel wire fabric
- Dowel bars
- Dowel (tie) bars
- Bar supports
- Epoxy coating

853.1.01 Related References

A. Standard Specifications

Section 514—Epoxy Coated Steel Reinforcement

B. Referenced Documents

AASHTO	ASTM	
M 32/ M 32M	A 153/ A 153 M	A 653/ A653M
M 55/ M55M	A 416/ A 416M	A 709/ A 709M
M 284/ M284M	A 421/ A 421M	A 722/ A 722M
		D 1248

QPL 12

QPL 55

QPL 61

CRSI Manual of Standard Practices

853.2 Materials

A. Requirements

NOTE: Notify the Office of Materials and Research at least two weeks before blast cleaning the steel reinforcement bars and applying the epoxy coating. This time will allow the Department to schedule an inspection.